ON CERTAIN PROPERTIES OF LIGHT-STRUCK PHOTOGRAPHIC PLATES.*

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The results to be given in this paper were obtained with a Töpler-Holtz machine having one 24-inch plate, and with no condenser attached to its terminals. The spark-length mentioned in the paper is the distance between the discharge knobs of the machine.

A parallel circuit consisting of ball-tipped brass rods about six feet in length led to the insulated stool upon which the photographic plate is placed for electrical exposure. A brass plate a foot square was placed on the top of an insulated stool, and formed one plate of a condenser. Upon this a much larger glass plate is placed, upon which rests the photographic plate. All of the results were obtained with the Cramer "lightning" plate. Some metallic object like a medal is placed upon the sensitive film, and forms the other plate of the condenser. A rod about a foot in length, having knobs, stands vertically over the medal. The knobs of the secondary or parallel circuit are separated from the plates of the condenser and from the machine terminals, by small spark gaps which may be varied. Such changes appear to materially affect the behavior of the machine and the details of the picture produced. The rods are all sleeved by glass tubing, and are then held by laboratory clamp stands. This arrangement for electrographing is well known although the photographic plate has heretofore been protected from the light.

The method which has been found most convenient for manipulation is to first expose the plates to the light of an ordinary room for from one to nine days. A longer interval

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has not been tried, but some of the best results were obtained from the last of a box of plates which were all exposed at the same time, and which were not all used until nine days had elapsed. This method of treatment is advantageous because it is difficult to prevent light from the discharge from striking the plate during the electrical exposure, and a great over-exposure renders the plate more manageable in the subsequent treatment. It darkens much more slowly in the developing bath than when slightly light-struck.

The plate is put in position with the medal resting upon it. The capacity described gives a rather rapid sequence of small sparks, which may be made 15 cm. in length. At each discharge between the knobs of the machine, a discharge occurs on the film around and under the medal. This exposure may be from four to ten minutes. A much longer exposure reverses the picture and gives a positive. The exposure should be in a darkened room, and the light from the spark should be kept from the plate by a screen. Light falling on the plate while the electrical action is taking place, counteracts the electrical action in a very remarkable way. This may be shown by partly closing the blinds of a window ten or fifteen feet away, forming thus a vertical slit a foot in width. The other blinds are to be wholly closed. A book set up so as to shade half of the plate yields results such as are shown in Fig. 1. This print is of course a positive from the original negative.

It is therefore evident that the time of exposure depends somewhat on the diffuse illumination in the room. A very dark room is not necessary.

It is also found that if the plate be exposed to light for a day or more after the electrical exposure, a similar counteracting effect is produced. In this way the picture may even be reversed and develop as a positive.

In developing the picture a cool and rather weak hydrochinone developer leaves nothing to be desired. The room should not be too dark during this operation. The best conditions are to be found in an ordinary dark room, lighted by a single incandescent lamp. The light should be five or six feet away, and any tendency to fog is remedied by taking the

plate nearer to the lamp. If already fogged, a plate may thus be cleared up in a very remarkable way. If the plate is too near the light during the whole time, there is a loss of detail. By allowing the developing to begin four or five feet from the lamp, moving it up as necessity arises to within two or three inches, and with a cool and weak developer, the picture may be developed for an hour if desired. During this time the details are coming out with continually increasing sharpness.

When the spark length is less than twelve or thirteen millimeters, no disruptive and luminous sparks are seen on the plate. There is a violet corona around the medal. The pictures given by the positive pole show radial discharges, bounded by a dark band, like a halo. For short spark lengths of 5 or 6 mm., the halo is close around the medal, and it increases in radius as the spark length increases. With a spark length of about sixteen millimeters, a dark halo appears distinctly on the plate before developing. This has been seen only a few times. Thus far it has not been found possible to save it. It washes out in the developer. It begins to fade and an inner one, apparently midway between it and the medal, begins to appear. The outer halo has disappeared, before the inner one has fully developed. When the developing is arrested at an earlier stage, the outer ring is lost in the fixing bath.

The shape of the dark halo conforms to the general shape of the body. In some cases, where disruptive effects of exceptionally strong character have passed, their tracks are shown on the negative. These tracks are in all cases distinctly broader and darker where they cross the dark halo, than elsewhere.

Figs. 2, 3 and 4 show some of the peculiarities mentioned. In Fig. 2 the spark is delivered to the large weight, but the smaller one is so near that it has very nearly the same potential as the larger. It is joined to the larger by a spark, which practically unites the two bodies at each discharge.

In Fig. 3 the smaller weight has a much lower potential than that of the larger. It corresponds nearly to that of the halo encircling the larger weight. In Fig. 4 the distance between the weights is still greater, and the smaller weight is at

a lower potential than that of the halo around the larger weight. With a spark length between thirteen and twenty millimeters, disruptive sparks begin to appear around the medal, and the discharge picture changes its character entirely. Not only is it greatly different from those previously described, but as in all other cases it does not correspond to the appearance which it presents to the eye. See Fig. 5. The visible spark discharges show a curious tendency to turn at right angles, and seem to be unsteady and flickering in their outer extremities. As the spark length increases the disruptive discharges become several inches in length, and the general appearance of the field as shown in the negative, is shown in Fig. 6. In this figure the spark is delivered to the larger disk. In most of these cases the development has been arrested before the tracks of the visible sparks appeared on the negative. No discharge like those shown on the negative can be detected by the eye. If the knobs of the machine are separated so widely that no sparks can pass, the brush discharge gives very feeble results if exposure and developing are otherwise done in the same way as before. This applies both to the image of the object and to the field around it. The oscillating spark discharge appears to be the important element rather than luminous or electrolytic action. Certainly the luminous effect is distinctly prejudicial.

The negative discharge shows much less of interesting detail. With short sparks, there is a smooth corona, looking like a brush shading in India ink. With longer sparks some radial line-work suggesting lines of force appears. See Fig. 7. The general appearance is much the same for short as for long spark lengths. When strongly illuminated during the electrical action, both positive and negative discharges give weak coronal effects in the negative, and the color is that of a sepia stain, or an untoned silver print. Most of the interesting features which the negatives show must be passed over without mention. They pertain largely to effects due to variation of capacity and spark gaps both in the main and the parallel circuits. The perfecting of the methods and the study of these features occupied a period of several months, and a large part of this work was done during 1896.

While recently observing a plate exposed to the negative discharge, half of which was shaded, a bright ball of light looking like a globule of molten metal rolled slowly out into the shadow from the brass weight. Its size appeared to be that of a pin's head. It moved somewhat irregularly and left a black narrow track in its wake. The discharges which had previously been in all directions around the medal were now all on the side occupied by the ball. They were less frequent, and the sparks were apparently within an angle of 30° or 40°. They, however, did not pass along the track of the ball, but rather appeared to avoid it. Another ball appeared from the same point on the coin and the first disappeared. The second ball soon diverged from the track of the first, and slowly made its way outwards. Several others followed. The plate was finally developed, and these tracks appeared as a branching system of black lines, wholly unlike anything before observed. The experiment was repeated, and a similar result followed. It was then thought that the shadow in which they made their appearance might be concerned in the phenomenon. In the next plate, however, the balls appeared in the part of the plate which was strongly illuminated. The development of this plate was pushed to the extreme. and the branching track began to appear blurred. On examination with a pocket lens, it was found that the tracks of the ordinary spark discharges could be detected where they crossed the tracks of the ball discharges. They were here intensified. Under the glass the spark discharges appeared indistinct and hazy, while the tracks of the balls were still sharp. See Fig. 1. When rephotographed and enlarged 100 diameters, the tracks of the balls on the original negative were found to be about 0.002 cm. in width.

Some changes were then made in the apparatus in order to provide more suitable conditions, and it was then found impossible to secure the result again after two days of persistent work. The old arrangement was then resorted to with like results. It was observed that the ball discharges came from the same point on the brass weight. A short radial pencil line was drawn on the plate at this point with no result. There seemed to be no irregularity at the point of discharge

that could account for the peculiar discharge. The brass wheel of a clock was selected, and all but one of its pointed cogs were removed, with no better result. A return to the weight gave a successful result, but continued repetition resulted again in failure. A radial line was again drawn with a different pencil from that formerly used, and with a successful result, but this was again followed by a long list of failures. It was finally found that the mark of a moistened pencil would always yield the desired result.

This threw discredit upon the idea which had begun to prevail, that a definite frequency of oscillation was involved, and which only a fortunate combination of adjustments could secure. After a month of experimenting in this way the conditions favorable to the immediate production of the phenomenon were found.

The secondary circuit was discarded, and the metal disk from which the discharge is to come was put in contact with the negative knob of the machine. The disk was armed with a radially placed needle point, which touched the sensitive film. No condenser was used in the machine, and the knobs were separated so that no visible discharge could occur between them. A needle point is also presented to the point on the surface of the film. A very effective device consists of two needles or pins with their eye or head ends lashed together, and attached with sealing wax to the end of a glass tube serving as a handle. The needles form the arms of a T of which the glass tube is the trunk. One point is held near the point from which the balls are to issue upon the film. The other point discharges upon the air. This device has earned the name "teaser." It seldom fails to bring the ball discharge at once. The mark of a moistened pencil upon the film at the discharge point is sometimes needed. The teaser may also be used to lead the balls into abnormal paths upon the plate. When this device was hit upon, it was at once used to determine whether ball discharges could be drawn from the positive pole. The discharge point was placed at the positive pole, with the teaser held in front of it. The balls appeared, but they issued from the teaser and passed to the positive pole. Several negatives were obtained in which

short discharge tracks exactly resembling those of the ball discharge, were found originating in irregularities of the film. This suggested the experiment, the details of which are shown in the adjoining cut. A disk, *b*, *c*, was armed with two needle points, one of which was directed towards the point *a*, from which the ball discharges issue. The other was directed in an opposite direction. The positions of the knobs of the machine are shown in the cut. A very luminous ball discharge passed very slowly from *a* to *b*, requiring about a minute to traverse one inch. At *b* the luminosity disappeared, but it appeared at once at *c* and drifted around towards the + knob. It reached the edge of the plate at *d*, and remained

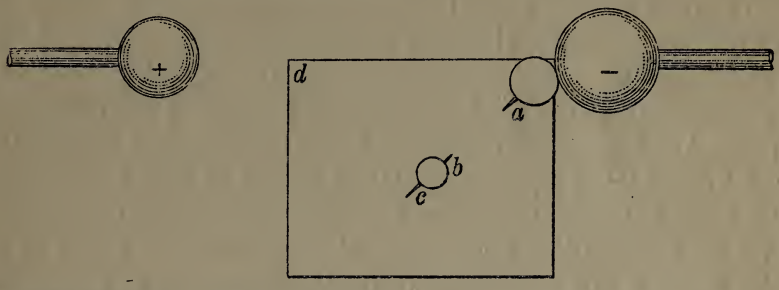

Diagram Showing the Arrangement of Discharge in Pl. XV., Fig. 8.

there for several minutes. A little rivulet of violet discharge passed along the whole line of the track and was especially strong near *a*. After developing it was found, what has been seen in several other plates, that the film was attacked along this part of the track, as is shown by dendritic formations extending outward from the main track but which do not show in the half-tone reproduction. When the machine was stopped and the flow along this line ceased, it was found on starting the machine that this track had ceased to act as a conductor. No glow appeared at *d*. Another ball discharge appeared. It was drawn out and to one side of the old track by means of the teaser, and then was allowed to traverse its own path. It found its way by a new path, to *b* and *c*, and finally to the edge of the plate. There it also persisted, but the machine was soon stopped, and the glow ceased. This was repeated many times. The result is shown in Fig. 8.

It was found in this experiment, as in all others, that the track of a ball discharge is a good conductor, so long as the ball discharge is in existence at the end of the path. It affects the operation of the machine in a very remarkable way, as has been explained, when strong disruptive discharges are taking place. If a ball discharge intersects the track of another ball discharge, it will sometimes move along this track with great speed, but sometimes it disappears and at the same time it reappears on the same track further away from the cathode. But as a rule these balls cross and recross old tracks while running closely parallel to them, without being in the least affected by their presence.

It is not probable that these discharges are really spherical in form. Sometimes they do not even appear spherical. The phenomenon is apparently the result of a breaking down under electric stress of the medium composing the sensitive part of the film. The chemical action results in the formation of a track along which a discharge passes to feed and maintain these luminous nuclei. This discharge along the track between the cathode and ball is usually invisible, even in a dark room, but its existence can always be shown by passing the point of the teaser along the track. By separating the knob of the machine from the disk bearing the discharge point this silent brush discharge also becomes apparent.

If a drop of water be put on a not too clean plate of glass, and at the end of the discharge point *a* of diagram, the water is drawn out into long narrow tracks. They originate at points of maximum curvature, where a luminous point discharge appears. This action results in the formation of a conducting track which feeds the point discharge. But a similar action will take place at the positive knob of the machine. Only part of the conditions existing on the photographic plate are found here. The medium is a conductor, which is distorted by the acting forces. There is no chemical breaking down of the medium, resulting in the formation of a conducting channel.

After a plate containing a ball discharge has been fixed and dried, if it be replaced at either discharge knob of the machine, luminous ball discharges form along the tracks, but the con-

ducting material forming the track is quickly torn out and dispersed. In a few cases these points or ball discharges have been seen to move quickly along the old tracks, but as a rule they do not appear to be capable of motion. Such motions as have been seen were away from the cathode knob, and they consisted in most cases rather in a disappearance of a glowing ball-like mass at one point, and its reappearance at an adjacent point. Only one or two negatives gave results of any significance. In most of them the film as a whole had become either too good or too poor a conductor.

It is apparent that the gradual formation of a channel of somewhat lower resistance, is a material feature in the ball discharge. It is probable that the breaking down of insulating material by stresses due to high potentials will yield valuable results. Whether these ball discharges on the photographic plates are the same as those reported in connection with lightning, it is perhaps too early to decide. They are certainly similar. It is very probable that optical illusions are to be credited with some of the descriptions given of these phenomena. The remarkable photographs taken by Sidney Webb and recently published,* show that during lightning discharges, tracks stream out from arc lights. The line wire is a conducting channel. The arc itself is a point of weakness in the gaseous medium, by reason of its high temperature. At low temperatures, nitric and nitrous fumes when mixed with air, increase its resistance to the passage of sparks between discharge knobs; but at high temperatures the result is likely to be different. Certain it is that these photographs taken by Mr. Webb, show that just such discharges are formed in the air as are known to exist along the track of a ball discharge on the photographic plate.

In many cases where spark intervals have been specially adjusted, and a continuous violet brush discharge was seen passing along the track leading to a ball, persistent appearances resembling what has been described as bead lightning have been observed. These beads were really incipient ball discharges that were about to branch out from the main track. Such branches are seen in almost every negative secured.

* Nature, Feb. 8, 1900.

In many cases such attempts to form branch tracks prove abortive, but all of the tracks which are maintained for a sufficient time show most elaborate branches, of the most beautiful form. This is especially true when the photographic plate is not too near the machine, and when the teaser is only used to start a ball, which is then allowed to wander over the plate. The most interesting ball discharge yet obtained was found on a plate inclosed in a paste-board box in which photographic plates are packed. The discharge was disruptive in character. The negative terminal was a small knob in contact with the coin, from which a wire passed through the center of the cover, and was held in place by sealing-wax. The ball discharges wandered over the entire plate. They even branched off towards the coin and two such branches ran under the coin itself. The X-ray was playing upon the plate during the exposure, but this was apparently not an essential feature. The walls of the box undoubtedly did have some influence.

The essential differences between the three kinds of discharge described are well shown in Fig. 1, which contains them all. Ordinary visible disruptive sparks are shown most sharply in that part acted upon by the light during the discharge. They are not sharply defined, and are curiously bent near their outer ends. When first appearing on this negative, they were dark. As the development was pushed, they reversed. The dark corona on the negative immediately around the brass weight was produced by radiations along the lines of force. They were straight lines or nearly so, and the discharges which produce them are invisible. Within this coronal discharge in the shaded part of the plate will be found the track of a ball discharge, which on an ordinary silver print comes out very sharply, under a strong lens, but the reproduction will not bear very much of magnifying.

Fig. 9 shows a ball lightning discharge from a plate which was pushed somewhat in the developing bath. It would have been very nearly as good if it had been fixed without developing at all. It is, however, somewhat better to develop, if the arrangement has been such that disruptive sparks have not passed over the plate.

Fig. 10 is a reproduction of a portion of a negative showing ball tracks magnified about one hundred diameters. While these tracks were being traced, disruptive sparks were passing continually over the plate, and the tracks appeared somewhat obscured when viewed with the unaided eye. A pocket lens showed well defined tracks, and in the enlarged photograph the blurred effect has entirely disappeared.

This picture has been reversed twice, and shows the tracks in black as they appear on the original negative.

The fact that greatly over-exposed plates may be developed in the light, was suggested by the fact that in exposure to light during the taking of an electrograph, the electrical action was annulled. Finally when a plate which at first promised well began to fog in the dark room, the light of an incandescent lamp was turned on, and the plate at once cleared in a most remarkable way.

This again suggested the idea of developing X-ray pictures in the light. This has also been done with very satisfactory results. Light-struck plates were used for this purpose, which had been exposed for a day to the diffuse light of the laboratory. Singularly enough these pictures were negatives when they were inclosed in black paper during the X-ray treatment, and they were positives if they were exposed to the light while the X-ray was acting.

The advantage of being able to study an X-ray picture during the operation of the developing is sometimes very great. The operation may then be pushed until the desired features have been brought out, and it may be arrested before they are obscured by over-developing.

When the X-ray is thrown upon a plate in a camera while an ordinary picture is being taken, all exposed parts of the plate are affected alike. The action of light and of the X-ray are added. If a picture be taken of a diagram in black on white cardboard, the action of the X-ray will be shown equally on the dark and the light parts of the image. This is made evident by shielding half of the plate from the X-ray by a screen of metal or of lead glass. There is a marked difference between this result and that found for the superposition of light and electrical action, as is shown in

Fig. 1. In order that the X-ray picture of the metal fittings of the camera, and the light picture of the object in front of the lens may be superposed on the fixed plate, the diaphragm of the camera must be so set that the two pictures will develop in the same time with the same developing bath.

The results already described suggested that in ordinary photography the exposure might be so modified that the picture might be developed in the light.

In the first attempts that were made the object was a street scene. The exposures were from one to three and a fourth hours. The pictures developed in the light with perfect clearness. They are of course positives. They appear somewhat unpromising at first, while in the developing bath, and one is tempted to abandon them as failures, as indeed some of them may be, until experience is gained. The pictures obtained by these long exposures show some very interesting features. They show no trace of moving objects on the streets. In some cases hundreds of people passed. In one case ten street cars were blocked for twelve minutes, in the foreground, and cars were passing at the rate of 70 to the hour. Wagons were driven to the curb to deliver goods to houses, and people were standing on the street corners waiting for cars. In an exposure of an hour no trace of these objects could be seen on the plate when developed. The street appeared absolutely deserted. The car tracks show with distinctness. In one exposure of three hours and forty-five minutes a team and wagon stood in one position for twenty-eight minutes, and no trace of them appeared. If the exposure of the same plate is only for one second, these moving objects are all shown. Another feature of these long exposures is the entire absence of shadows. It is somewhat difficult to account for this, as it hardly seems possible that their motion is sufficiently rapid to produce this result. The sky appears absolutely uniform. Clouds which were in marked contrast in one case yield no trace upon the picture. An attempt was then made to shorten the time of exposure and still permit development in the light. This was done by subjecting the plate, while in the plate holder, to the X-ray.

The plate holder was held for ten minutes, six inches from a Crookes tube operated by a large induction coil in oil. A perfect picture of the hand could be obtained in six to eight seconds. The same plate was then exposed for two hours to a Crookes tube operated by a large eight-plate influence machine. The plate holder was then put into the camera and exposed to a street scene for ten minutes and was then developed in the light. The result is shown in Fig. 11. For reproduction of form and shadow, this plate could hardly be excelled by a transparency made in the ordinary way. Like the others, it shows no trace of moving objects on the street.

It has been long known that a slight over-exposure of a plate in the camera sometimes gives a positive picture when developed in the dark room. The experience thus far described made it seem probable that such pictures might also be developed in the light. This was found to be the case. If the proper exposure is one and a half to two seconds, an exposure of a minute is sufficient. Some that have been made have not been very satisfactory. But one has been obtained which is even superior to the plate reproduced in Fig. 11. It is shown in Fig. 12. For richness of finish and for perfect modulation of light and shadow, this original plate leaves nothing to be desired. During most of the time while being developed, it was held one foot from a sixteen-candle lamp. During some of the time it was held nearer, and during some of the time it was five or six feet from the lamp.

Figs. 11 and 12 are of course reproductions of the original positives. In these exposures the Cramer isochromatic plate was used.

In some of these shorter exposures where people or wagons halted on the street, they are shown on the fixed plate. Where they were motionless during the whole exposure they are of course shown with perfect clearness.

Experiment shows that a conspicuous object two feet in breadth and fifty feet from the camera if moved transversely at the rate of twenty feet per minute, during an exposure of one minute, will show on the plate as

a distinct trail. With a longer exposure it is eliminated. The unit of exposure may be roughly considered as one candle-meter-second. With a fixed illumination, the exposure may be varied, by varying the time of exposure. It appears that for any exposure, there is some definite degree of illumination in the dark room, which will yield what might be called a zero plate. No picture will appear on it if lights and shadows are each uniform on the object, as in case of a diagram in black on white cardboard. This picture will become a negative in a darker, and a positive in a lighter developing room. With an exposure of half a second a plate which will develop as a perfect negative in a proper dark room, will develop as a zero plate if the room is dimly lighted. In the parlance of the photographer, it will fog. In a still brighter light it will develop as a positive. In this action there must be a time co-ordination in the action of the developer and the light of the dark room. With a given strength of developer it appears from results thus far obtained, that a maximum degree of excellence will be secured with a definite degree of illumination in the dark room. The results thus far obtained with half-second exposures, are by no means satisfactory, considered as products of the photographer's art, but the pictures of street scenes are distinctly positives. If results comparable with those for longer exposures are attainable, it involves a delicate adjustment of the illumination of the dark room and strength of developer which has not so far been secured.

With an incandescent lamp burning in the dark room, it is easy in half-second exposures to obtain a rather poor negative, by holding the bath in the shadow of an object eight or ten feet from the lamp. By holding the plate in the light, and going somewhat nearer, the same plate with the same exposure, will yield a picture which is distinctly a positive.

With a very much over-exposed plate, it is difficult to get a room dark enough to yield a negative. With a very short exposure, it is equally difficult to get positives, and only by a very great illumination of the plate while in the developer. The condition of zero plate when only the time of exposure and the illumination of the developing room are variable,

certainly cannot be very different from an inverse proportion. The experiments thus far made show also that with a long exposure, the best results can be obtained by developing the plate in the light, as a positive, while for very short exposures the best results are attainable by developing as a negative.

These conclusions may be modified by a variation of the strength of the developer. The limits within which the variables may change and yield results of commercial value have not been determined with precision for positive pictures. What has been said of pictures taken in the camera, may also be said of X-ray pictures on plates not previously light-struck. If two plates are exposed in the same way to the X-ray, and one be developed in the dark and the other in the light, the former develops as a negative and the latter as a positive. Either may be converted into a zero plate by a change in the illumination of the plate while in the bath, as has been previously explained. The more careful study of these subjects is still in progress. There is ground for believing that the treatment of a plate by a slab of plaster of Paris moistened with peroxide of hydrogen, according to the method used by Russell * may be of value in developing X-ray pictures in the light. Work in this direction has not yet progressed sufficiently to warrant any final conclusions.

The superposition of X-ray pictures on electrographs does not as yet reveal any effect of either agent upon the action of the other. This has been done with fresh plates and with those which had been previously light-struck. In these experiments half of the plate was shielded from the X-ray by a heavy plate of lead glass. The pictures due to the two sources were superposed, and the two effects were added where simultaneously acting. This is also in marked contrast to the action of light on the electrograph, as is shown in Fig. 1.

The superposition of X-rays upon a plate in the developing bath while in a dark room promises interesting results, but so far this has not been done from lack of time.

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* Science, March 30, 1900, p. 491.

EXPLANATION OF ILLUSTRATIONS.

Plates XII–XVII.

Plate XII. — 1, Electrograph with light from one window falling on the left half of the plate. The right half is in shadow. Negative pole. — 2, Electrograph with positive pole with plate exposed in a moderately dark room. Discharge upon the large weight.

Plate XIII. — 3, Same with small weight at a greater distance. — 4, Same with the small weight still further removed.

Plate XIV. — 5, Same with greater spark length. — 6, Same with still greater spark length.

Plate XV. — 7, Electrograph with negative pole, long spark length. — 8, Ball lightning discharges. — See diagram in text. Fig. 8 has been reversed in the reproduction.

Plate XVI. — 9, The same as Fig. 8. — 10, The same enlarged 75 diameters and shown twice reversed.

Plate XVII. — 11, Ordinary photograph — exposure 10 min. on a plate previously fogged for two hours in X-rays, and developed as a positive in the light. — 12, An ordinary photograph — exposure one minute. Developed in the light. The original is also a positive.

Issued May 16, 1900.

FIG. 1.

FIG. 2.


30
GRAIN
U.S. STANDARD
300
GRAIN
PHILA.

FIG. 3.

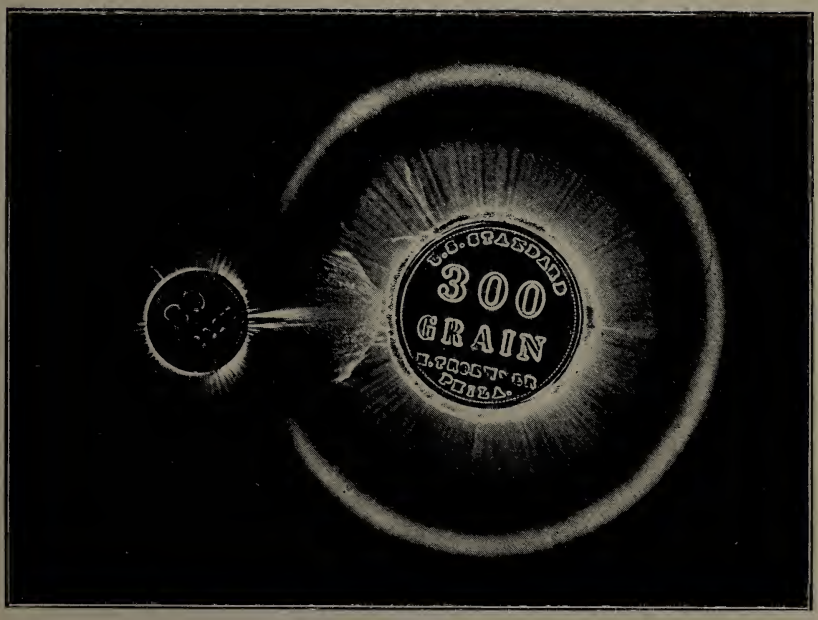
U.S. STANDARD
300
GRAIN
PHILA.

FIG. 4.

FIG. 5.

FIG. 6.

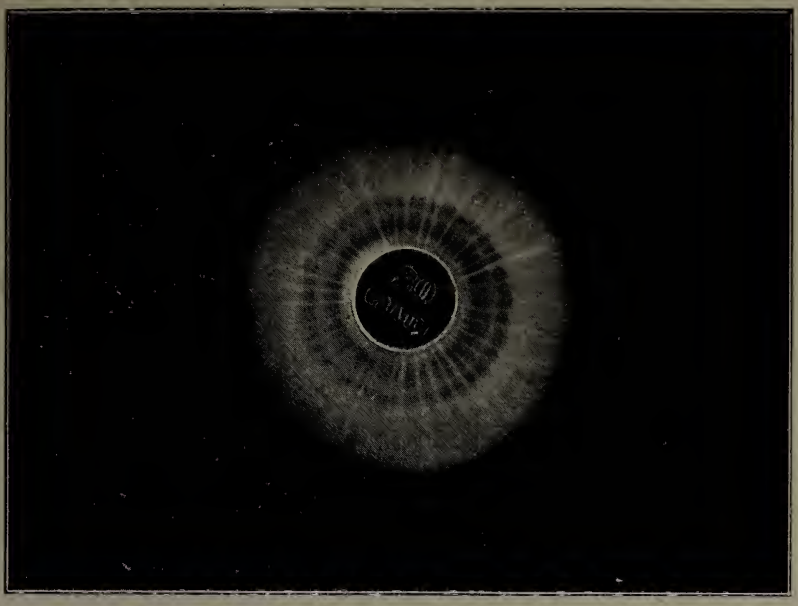

FIG. 7.

FIG. 8.

FIG. 9.

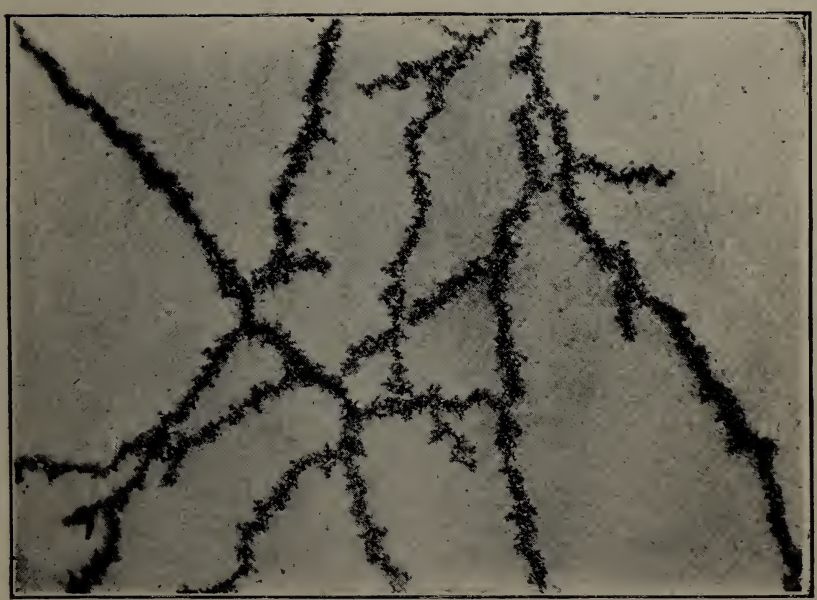

FIG. 10.

FIG. 11.

FIG. 12.